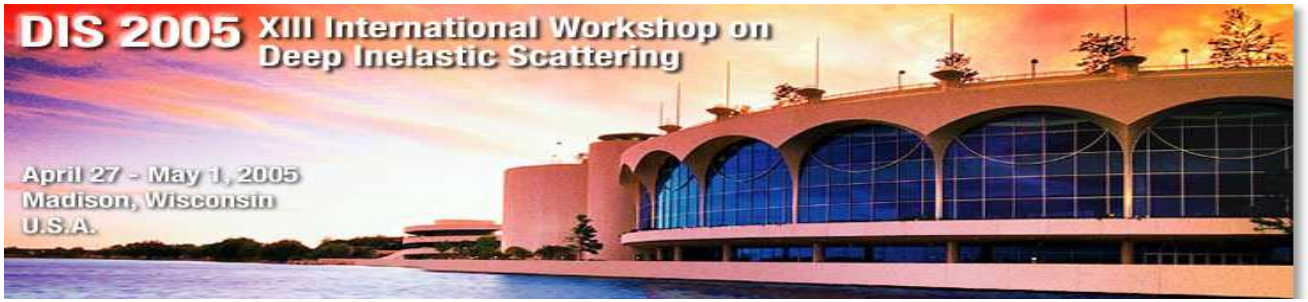


The Structure of Charm Jets in Deep-Inelastic Scatering

Adrian Perieanu

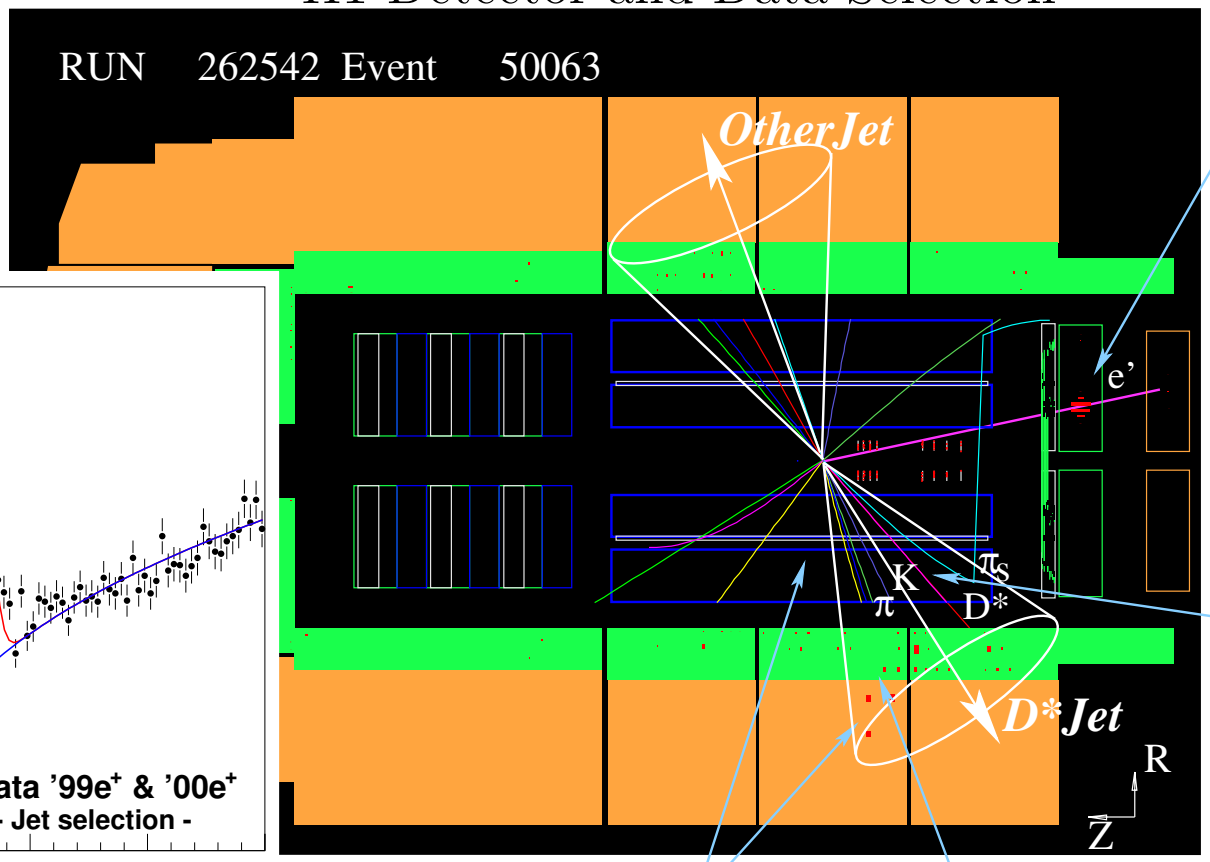
FH1 - DESY

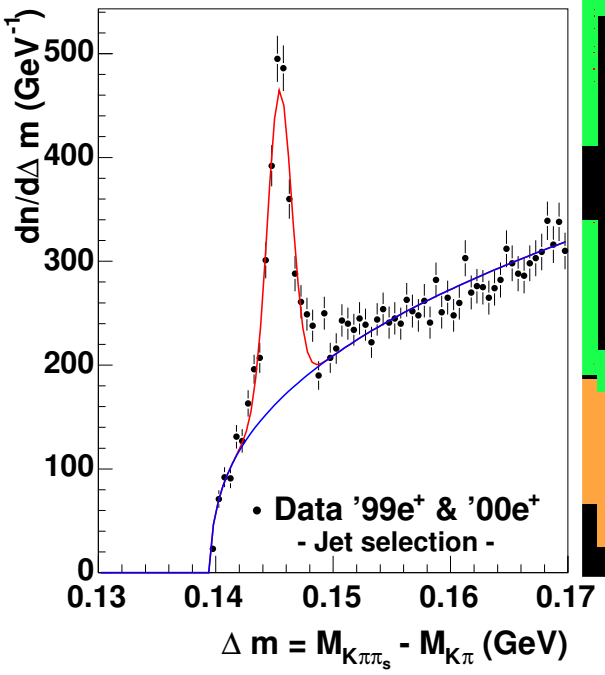
DIS 28^{th} **April 2005 Madison**

- Introduction
- Structure of Charm Jets: D^*Jet & $OtherJet$
- Experimental Methods
- Conclusions

Introduction I

H1 Detector and Data Selection





RiCh: $D^{*\pm} \to \overline{D}^0 \pi_s^\pm \to K^\mp \pi^\pm \pi_s^\pm$

WrCh: $D^{*\pm} \to D^{\pm\pm} \pi_s^\mp \to K^\pm \pi^\pm \pi_s^\mp$

SpaCal

DIS:

$2 < Q_e^2 < 100$ GeV^2;

$E_e > 8$ GeV;

$0.05 < y_e < 0.7$;

$40 < E - p_z < 75$ GeV;

CJC

D^*:

$|\eta_{K,\pi,\pi_s}| < 1.5$;

$p_{t\,\pi_s} > 0.12$ GeV;

$p_{t\,K,\pi} > 0.25$ GeV;

$|\eta_{D^*}| < 1.5$;

$p_{t\,D^*} > 1.5$ GeV;

KtJetFinder

Jets:

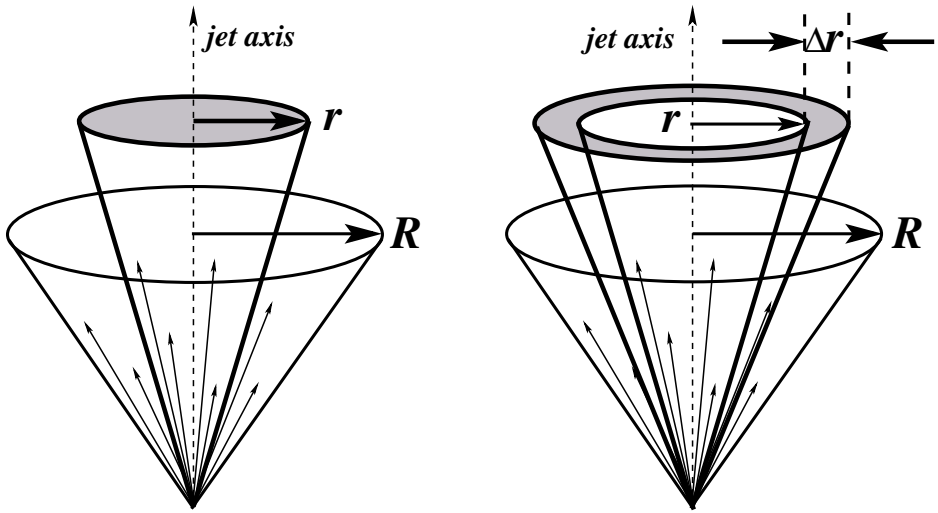
$|\eta_{Jet}| < 1.5$;

$p_{t\,Jet} > 1.5$ GeV;

LAr

Introduction II

Charm Jets Structure – Jet Shape Variables



Ψ(r/R) **ρ(r/R)**

$$\Psi(r/R) = \frac{E_t^{jet}(r)}{E_t^{jet}(r=R)}; \qquad \rho(r/R) = \frac{d\Psi}{dr} = \frac{E_t^{jet}(r, r+\Delta r)}{E_t^{jet}(r=R)}$$

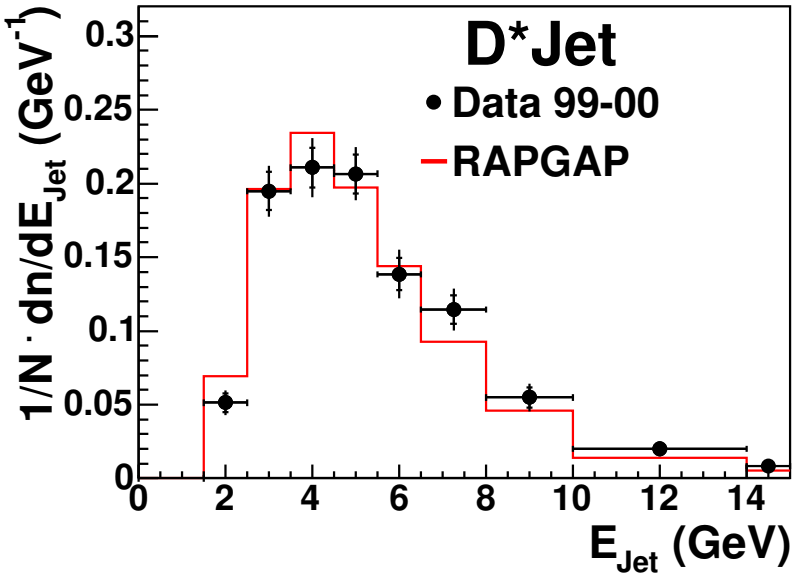
$$n_{sbj}(y_{cut})$$

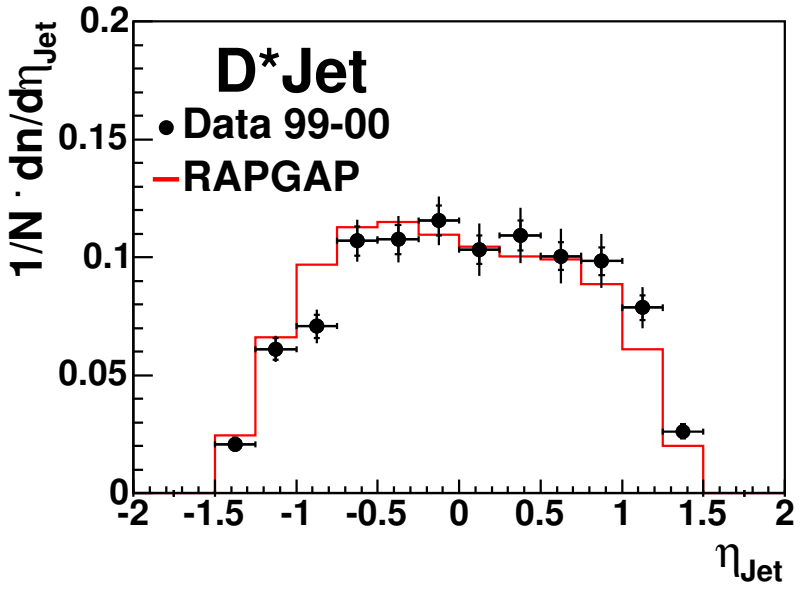
$< \Psi >, < \rho >$ – measure the *energy flow* around jet axis; sensitive to parton nature of the jet

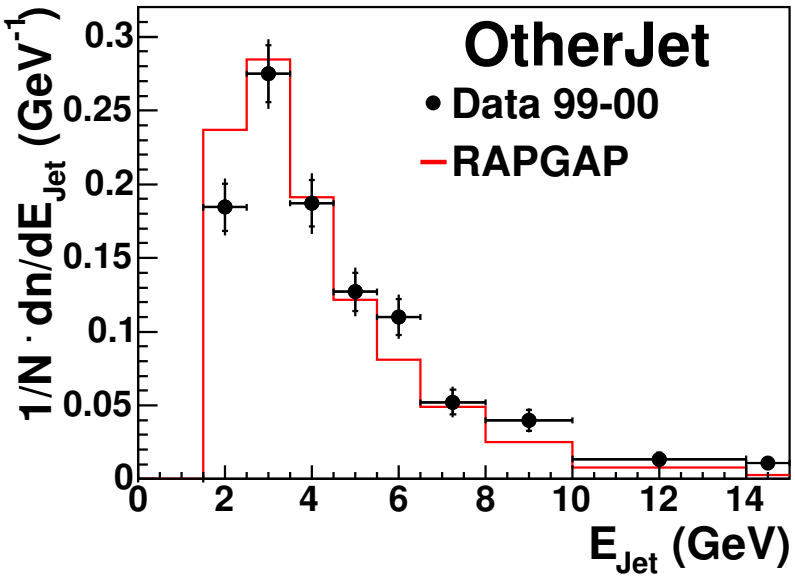
- close to jet axis → *soft gluon* emission effects (e.g. *Dead Cone Effect*)
- far from jet axis → large angles gluon emission (perturbative calculations)

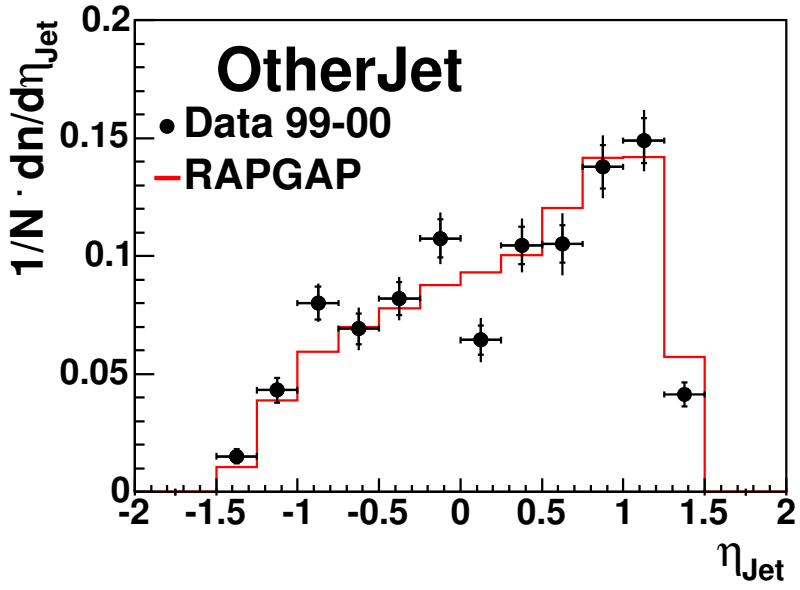
$< n_{subjets} >$ – the jet internal structure → partonic image description (depending on y_{cut})

Charm Production: E_{Jet} & η_{Jet}

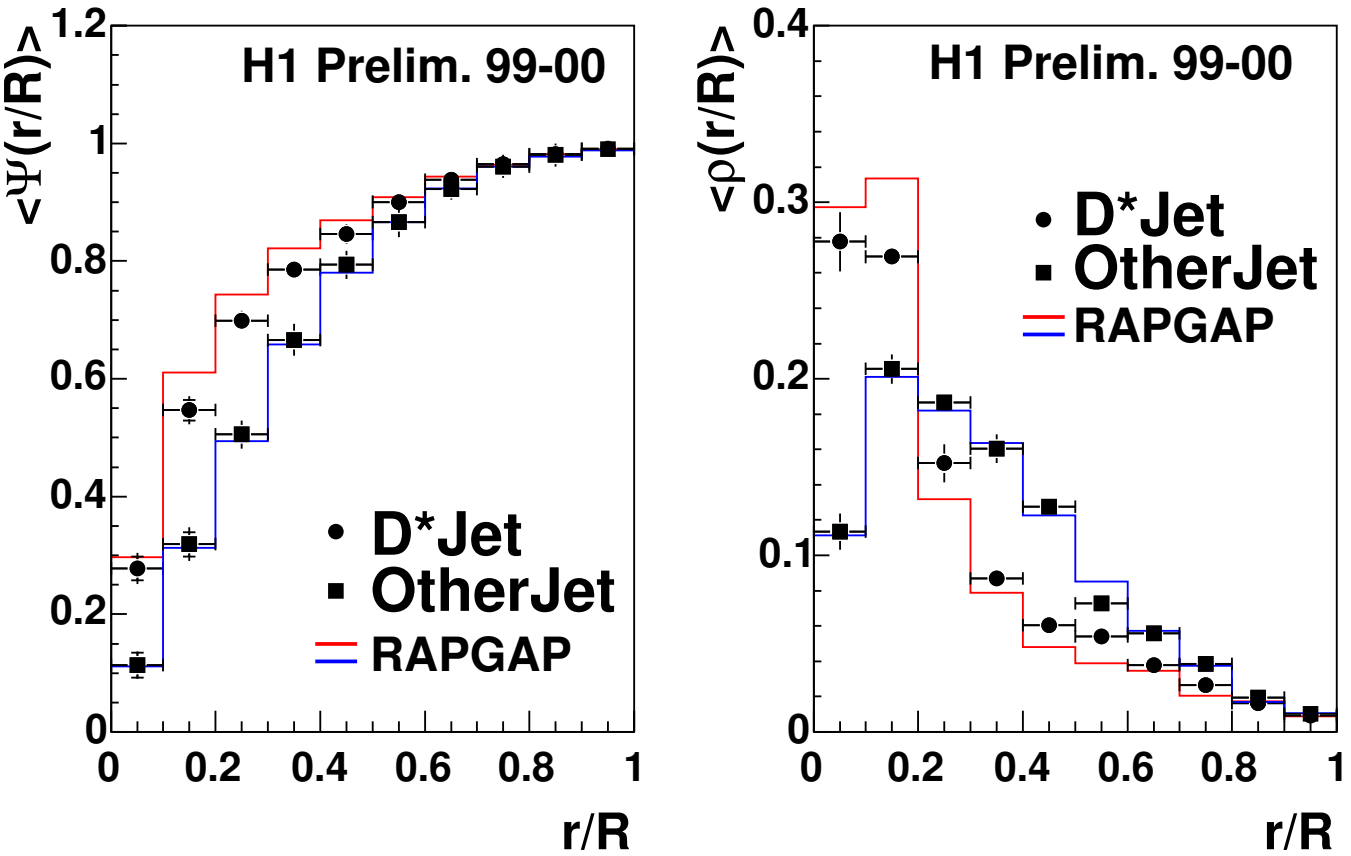






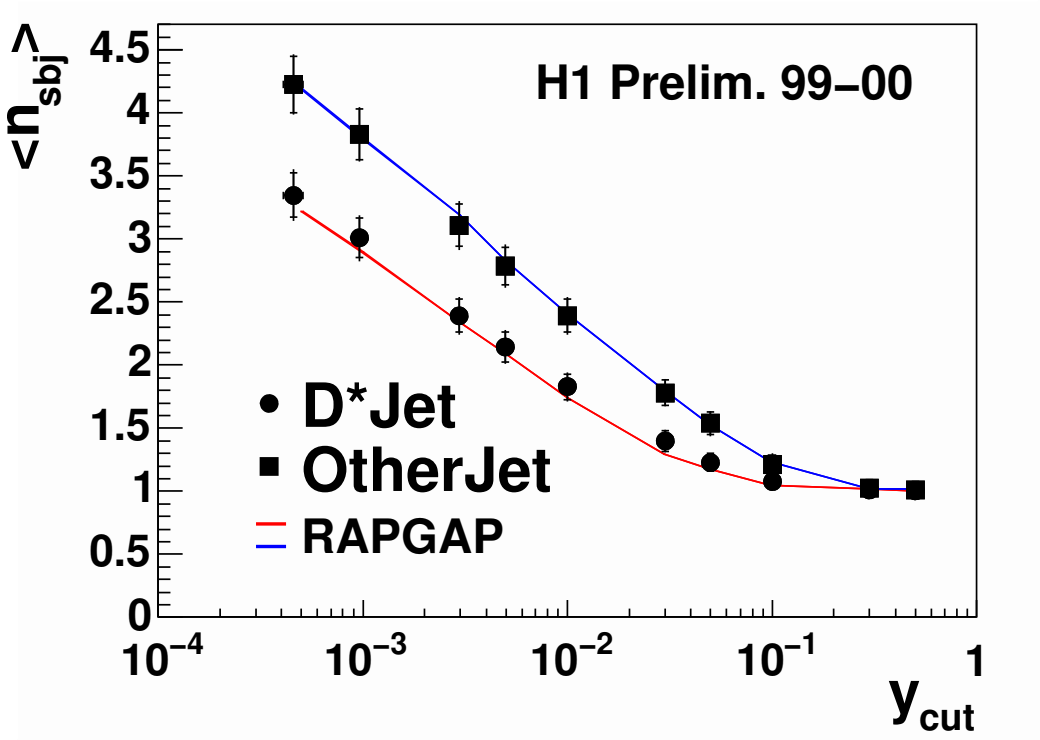


Jet Shape Variables: $<\Psi>$ & $<\rho>$



- *the MC model describes the Data very well*
- interesting differences between D^*Jet & $OtherJet$

$< n_{sbj} >$



- low $y_{cut} \sim 10^{-4} \rightarrow$ hadronization effects
- medium $y_{cut} \sim 10^{-3} - 10^{-2} \rightarrow$ 'partonic' subjets (subjets $\leftrightarrow$ *partons*) $\Rightarrow \alpha_s$
- high $y_{cut} \sim 1 \rightarrow$ the jet itself (one of the charm quarks from *boson gluon fusion*)

•this analysis: let y_{cut} free until 2 *subjets* only are found: a *quark* and a *soft gluon* subjet

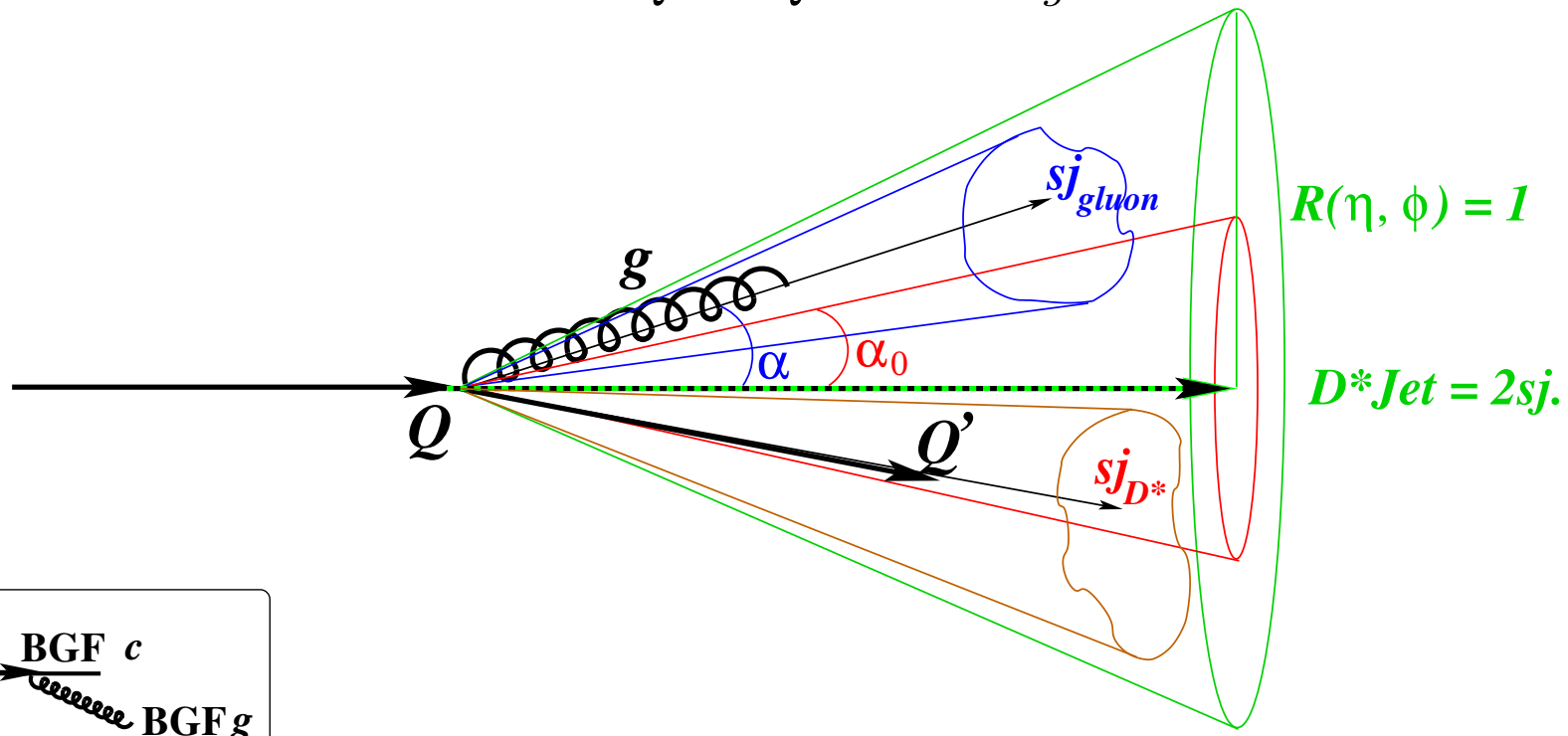
The Method: D^*Jet

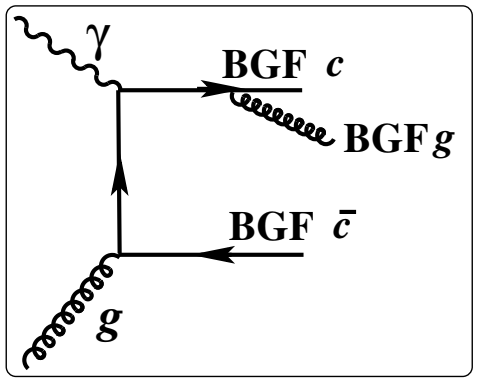
- Reconstruct D*
- Find Jet containing the D^* meson: D^*Jet
- Find Subjets

(stop the Kt algo. when 2 have been found)

$$D^*Jet \rightarrow sj_{D^*} + sj_{gluon}$$

$$BGF\ Q \rightarrow Q' + BGF\ g$$



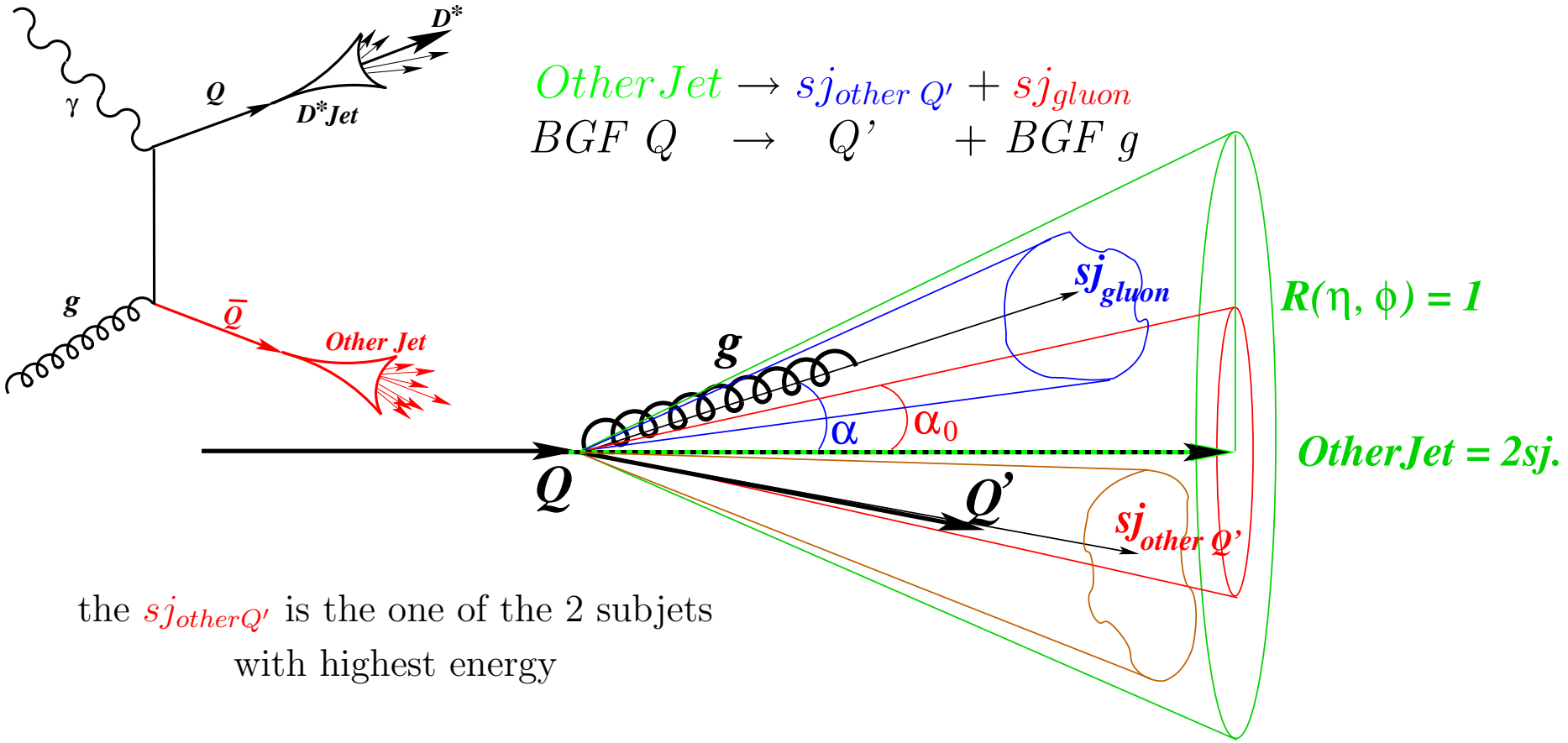


$$\alpha = \measuredangle(D^*Jet, sj_{gluon})$$

but, D^* itself is not introducing a bias?

how does the result depend on existence of a initial heavy object?

The Method: OtherJet



the $sj_{otherQ'}$ is the one of the 2 subjets with highest energy

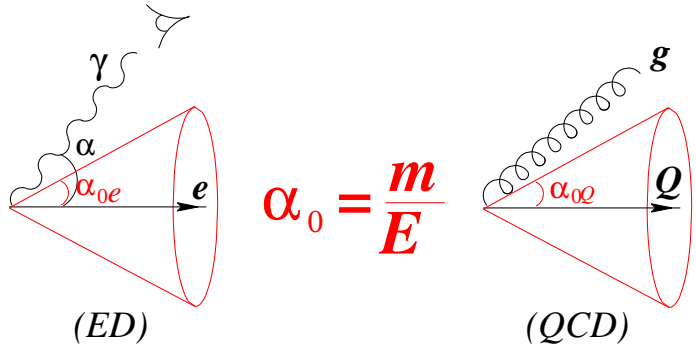
$$\alpha = \measuredangle(OtherJet, sj_{gluon})$$

no more D^* bias

but, how well is the charm reconstructed by the $OtherJet$?

soft gluon emission – Dead Cone Effect

in any frame the *radiation* of γ/g is *suppressed* within a cone with angle α_0 around the direction of $e/Q \Rightarrow$ *dead cone effect*

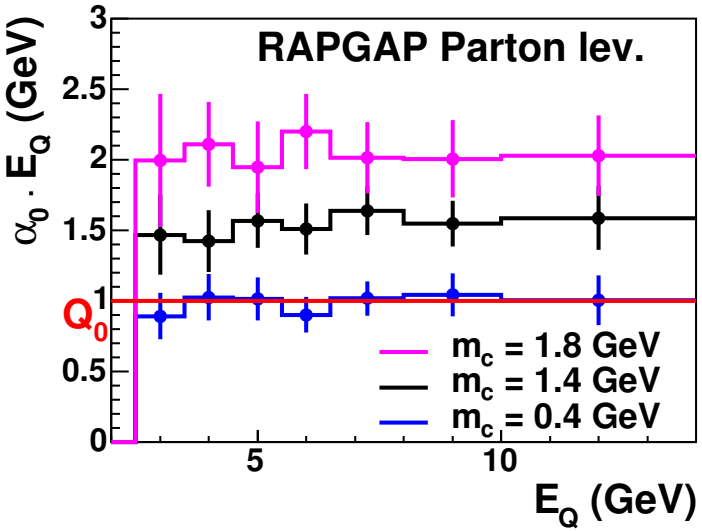


For ***charm***:
- at LEP: $E_c \propto 45$ GeV $\Rightarrow \alpha_{0c} \sim 0.034$ rad
- at HERA: $E_c \propto 3-5$ GeV $\Rightarrow \alpha_{0c} \sim 0.3-0.5$ rad

QCD

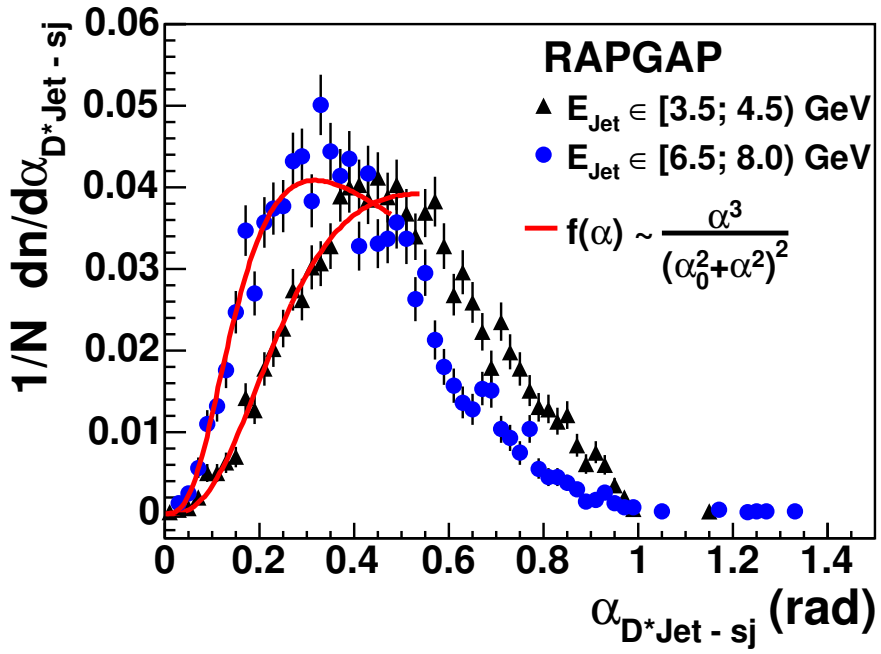
(Yu.L. Dokshitzer, V.A. Khoze, S.I. Troian)

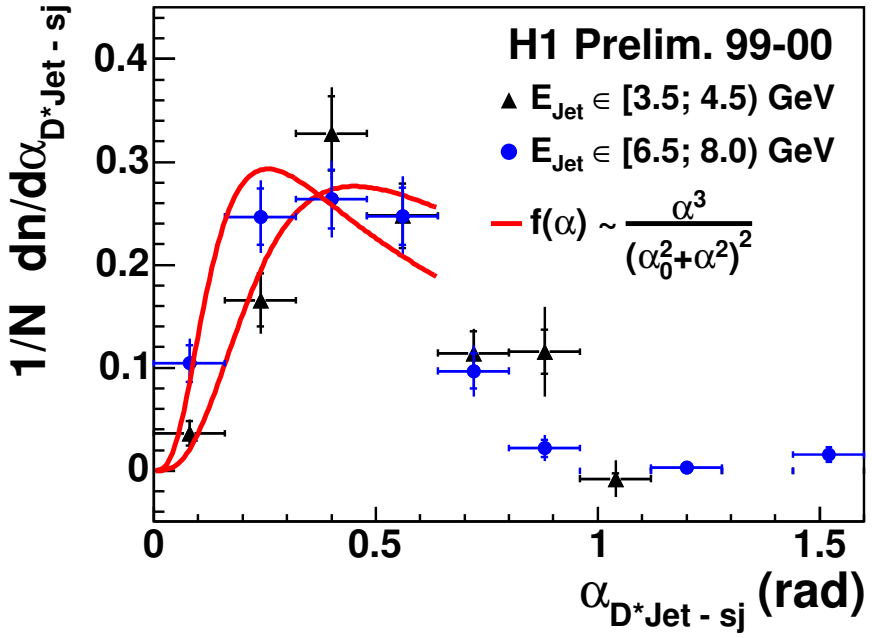
$$\frac{d\sigma_{Q\to Q+g}}{d\alpha} \simeq \frac{\alpha_S}{\pi} C_F \cdot \frac{\alpha^3}{(\alpha_0^2+\alpha^2)^2} \quad for\ small\ \alpha$$



Dead Cone Effect

– getting α_0 –



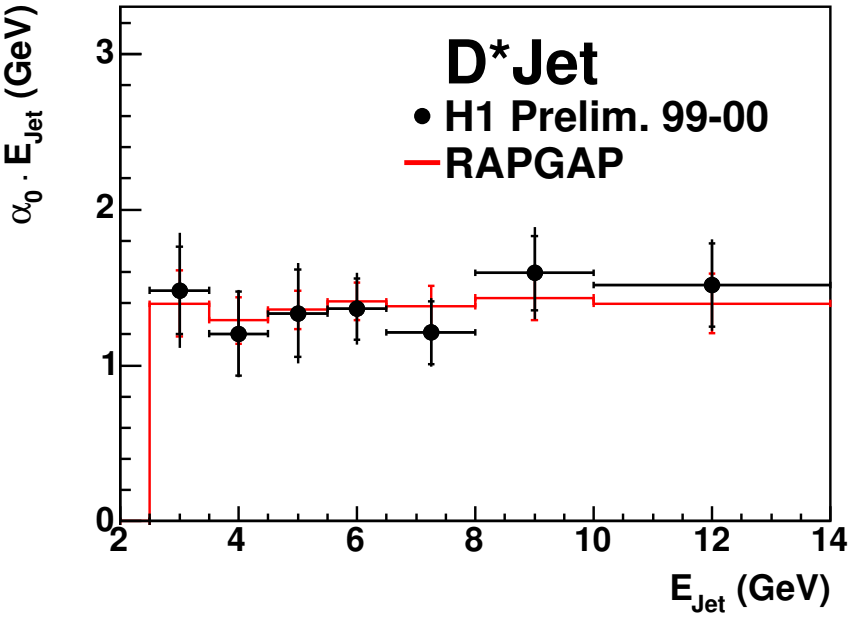


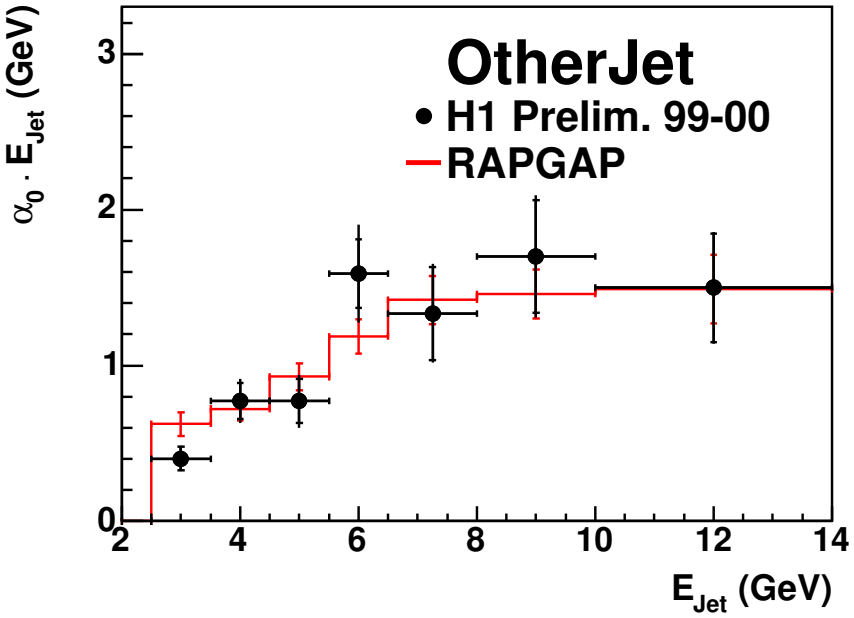
- the α distribution is shifting towards to 0 with increasing E_{Jet} as expected

fit function from theory: $f(\alpha) \propto \alpha^3/(\alpha_0^2 + \alpha^2)^2$

- the fit works well

$\alpha_0 \cdot <E_{Jet}>$ *distribution*





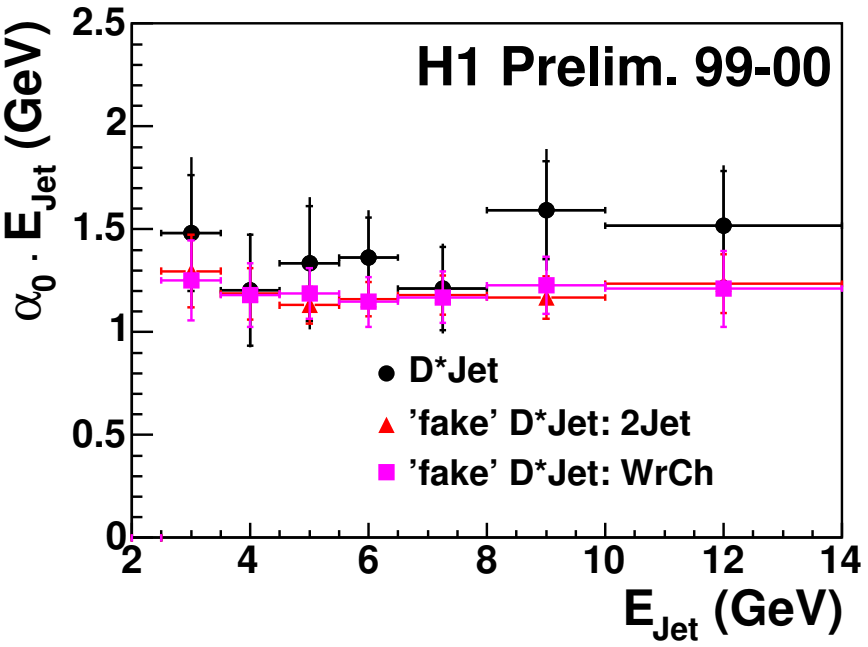
- *the QCD model describes the Data very well*
- the behavior of $\alpha_0 < E_{Jet} >$ is different for the two types of jets
- at low $E_{OtherJet}$ one observes in MC — worse *charm-jet* correlation than for D^*Jet
  — 'wrong' jets (from *'hard' gluons* and *uds* quarks)
- the value of $\alpha_0 < E_{Jet} >$ is similar with the one at Parton level in MC

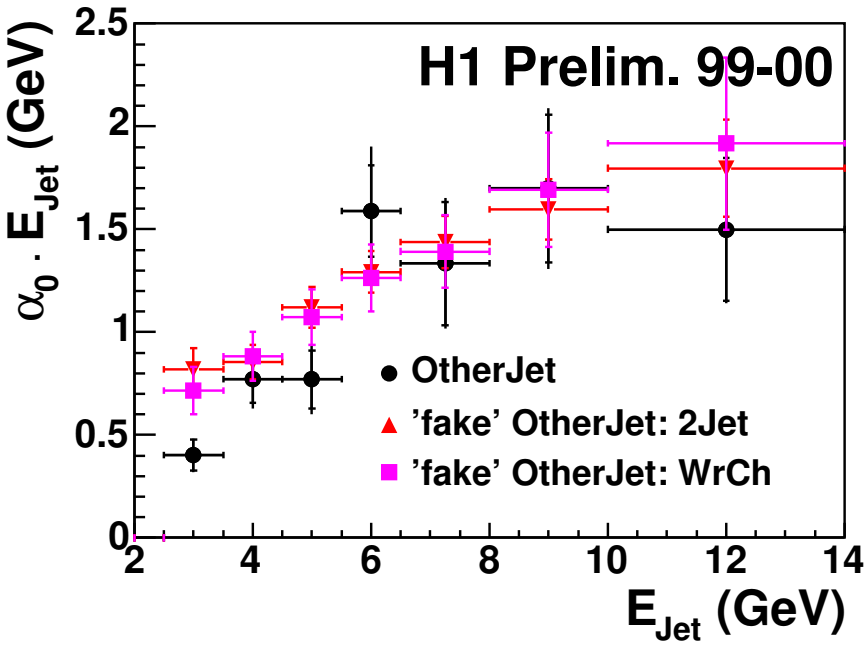
HOWEVER:

- how relevant is it that $\alpha_0 < E_{Jet} >$ is flat? or that $\alpha_0 < E_{Jet} > \simeq 1.4$ GeV?

$\Rightarrow$ check behavior of $\alpha_0 < E_{Jet} >$ for Wrong Charge or $2Jets$ 'fake' D^*? dependence frame?

Comparison of D^*Jet & OtherJet to 'fake' charm data





- usage of a 'fake' D^*Jet $\Leftrightarrow$ heavy object with similar phase space

$\rightarrow$ 'fake' D^*Jet in $2Jet$ sample ($uds \gtrsim 80\%$)

$\rightarrow$ 'fake' D^*Jet in $WrCh$ sample ($uds \sim 70\%$)

- *The distributions look somewhat different from the ones from charm jets but 'agree' within the errors.* - *Further studies and more statistics are needed to clarify these differences.*
- *At the moment they do not allow any conclusion concerning the Dead Cone Effect.*

Conclusions

• the Structure of Charm Jets was investigated

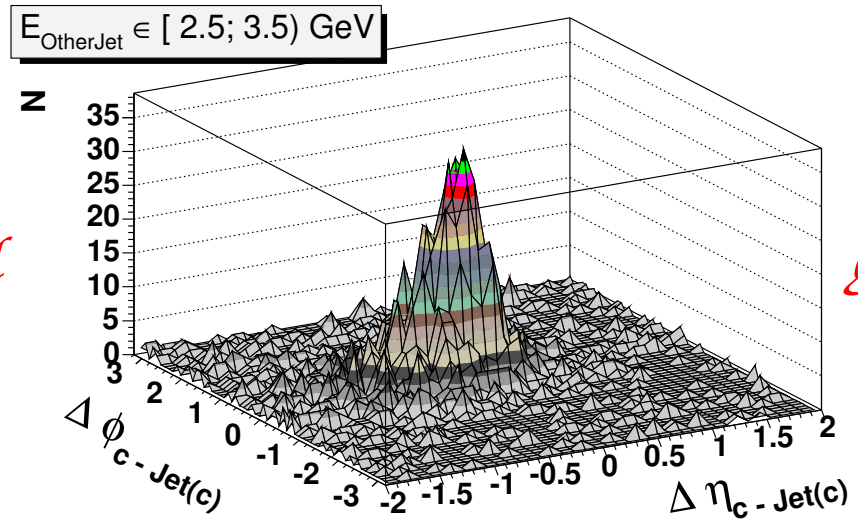
• the Jet Shape variables $< \Psi >$, $< \rho >$ and $< n_{sbj} >$ are well described by the QCD model; as are the interesting differences between the D^*Jet and $OtherJet$ observed

• a direct method using $\alpha_0 < E_{jet} >$ to measure the Dead Cone Effect has been presented; the data are well described by the QCD model

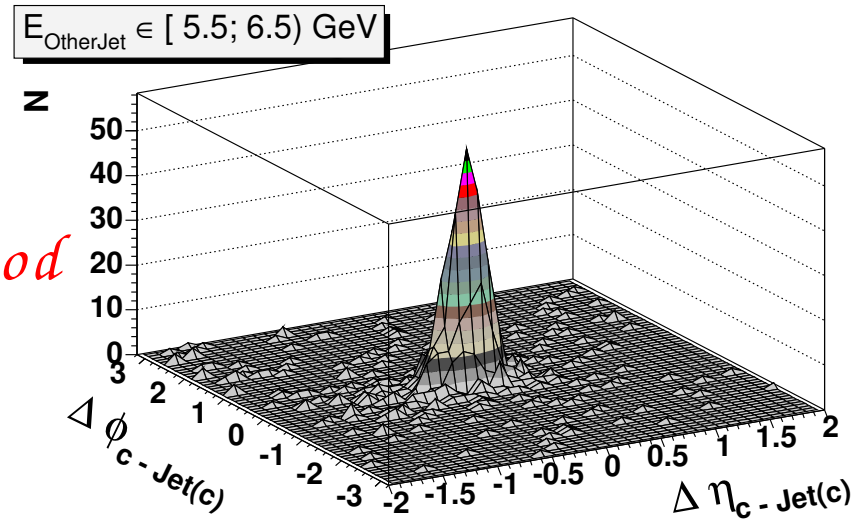
• the comparison between the *charm* and light flavour enhanced ($2Jet$ and $WrCh$) event samples do not show a clear difference to alow for now any conclusions concerning the Dead Cone Effect

OtherJet vs. $\mathcal{D}$*Jet

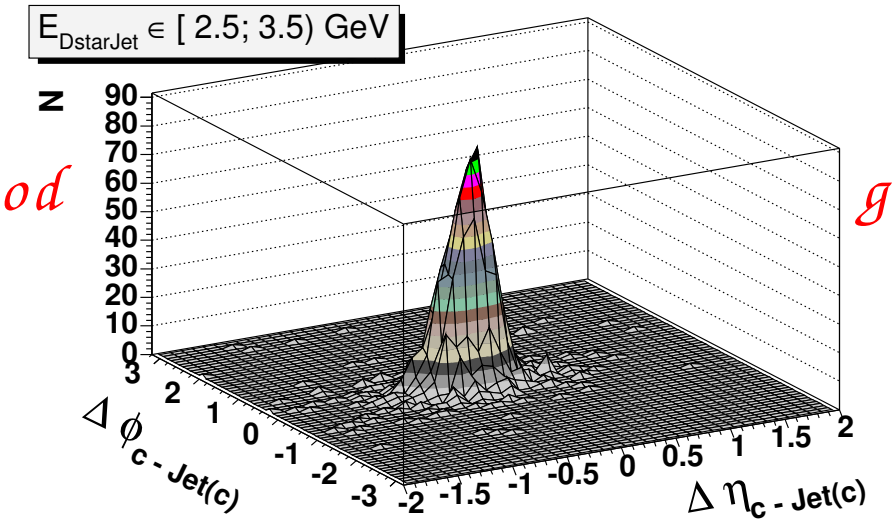
bad



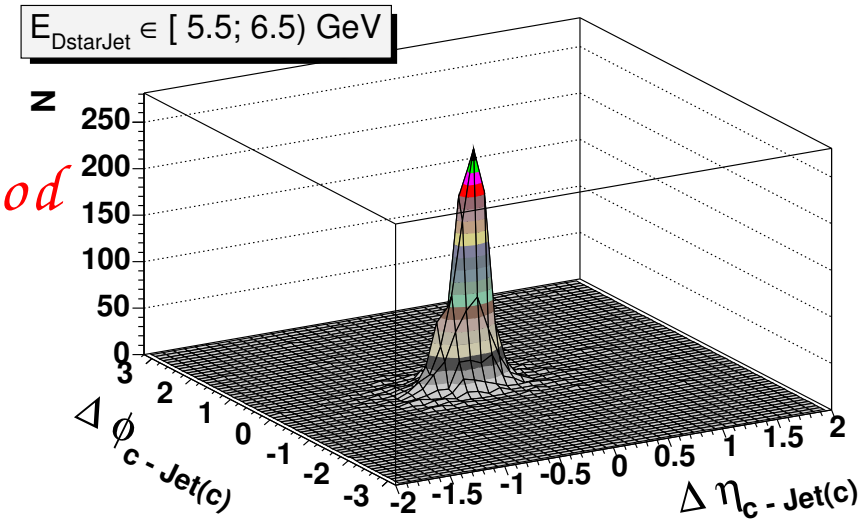
good



good

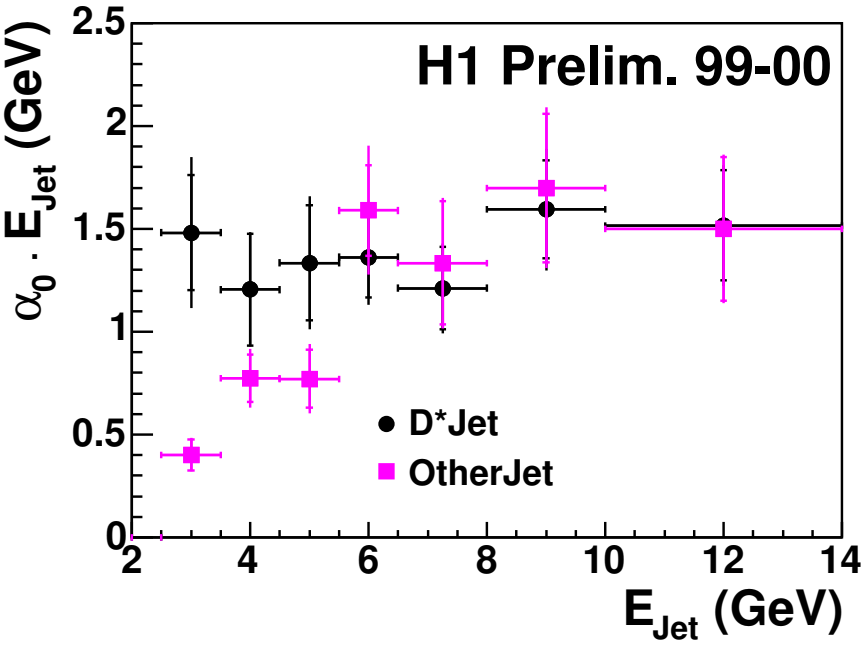


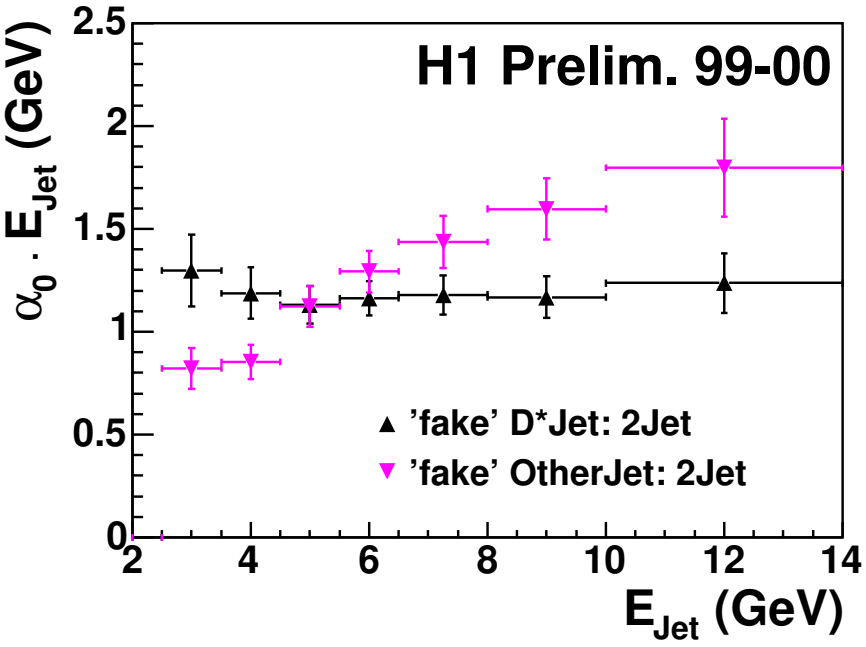
good



for $E_{OtherJet} < 5$ GeV the *charm* is not well reconstructed

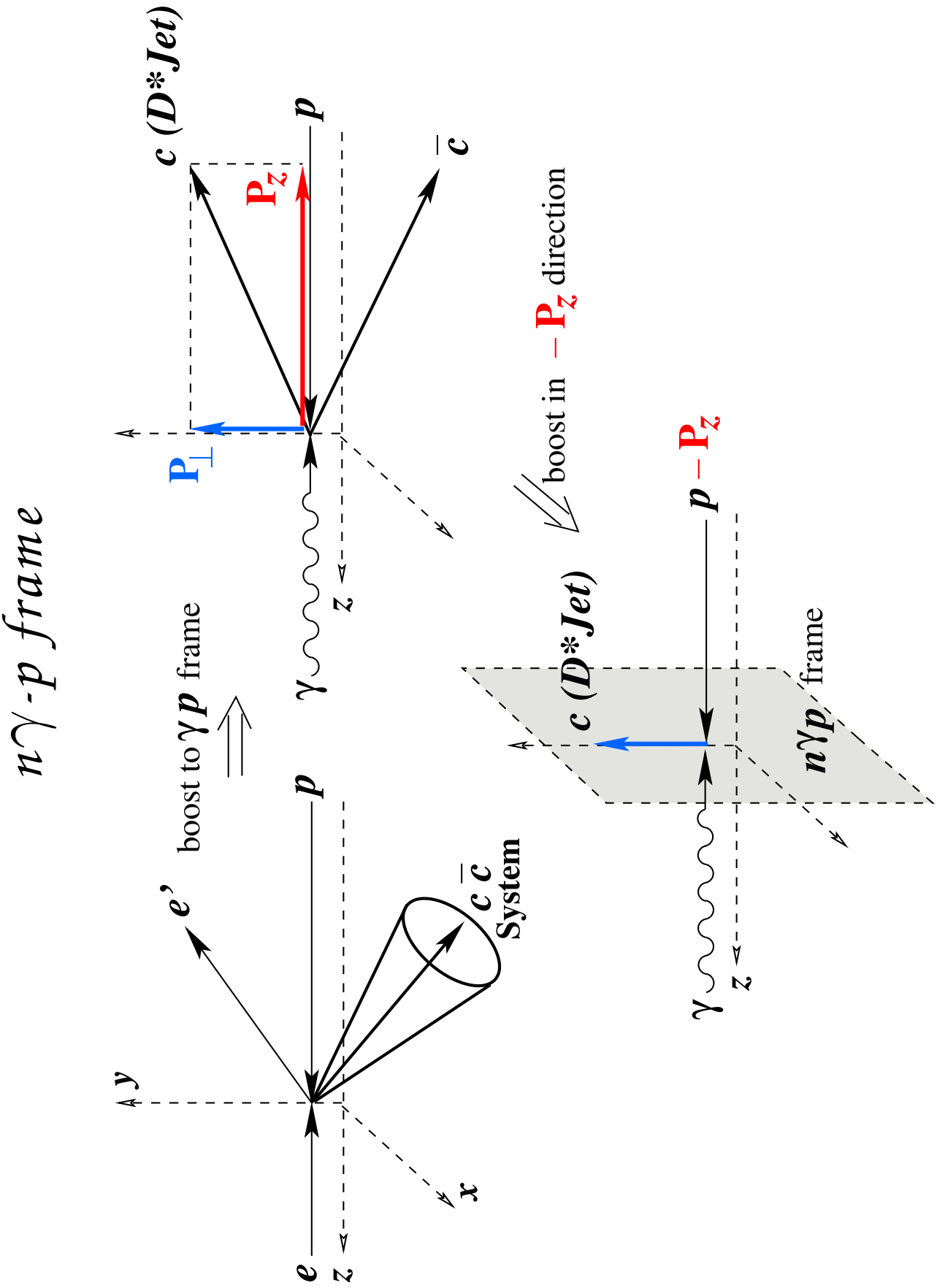
Comparison – charm ev. & 2Jet ev.–



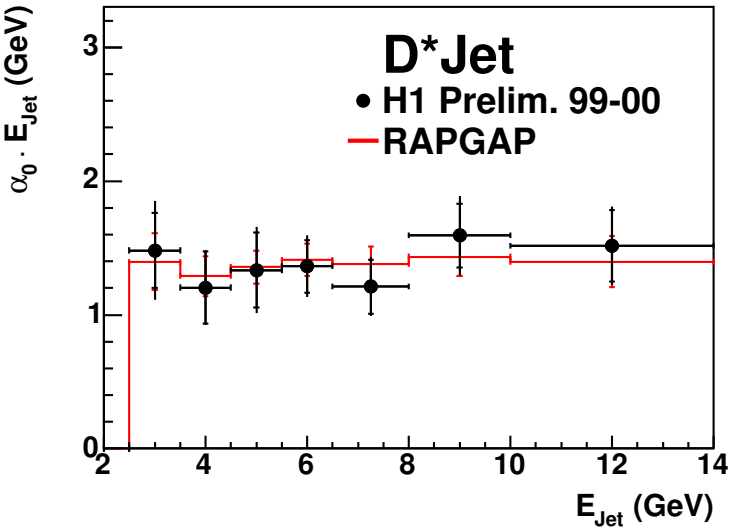


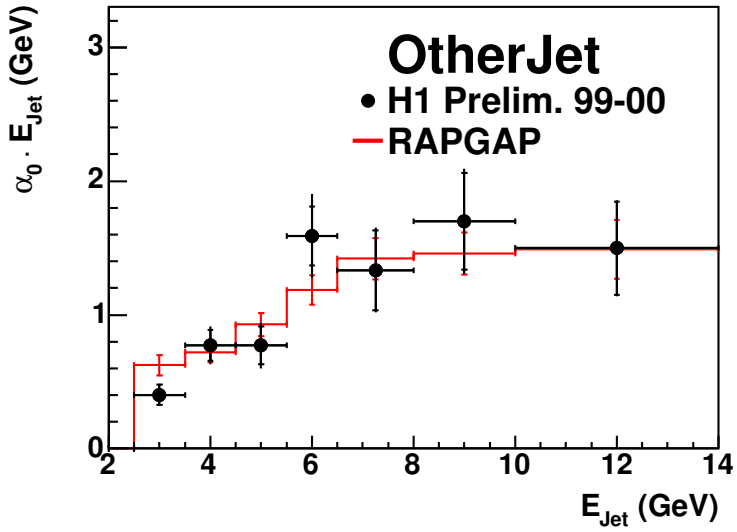
- one observes a different behaviour between the two event samples

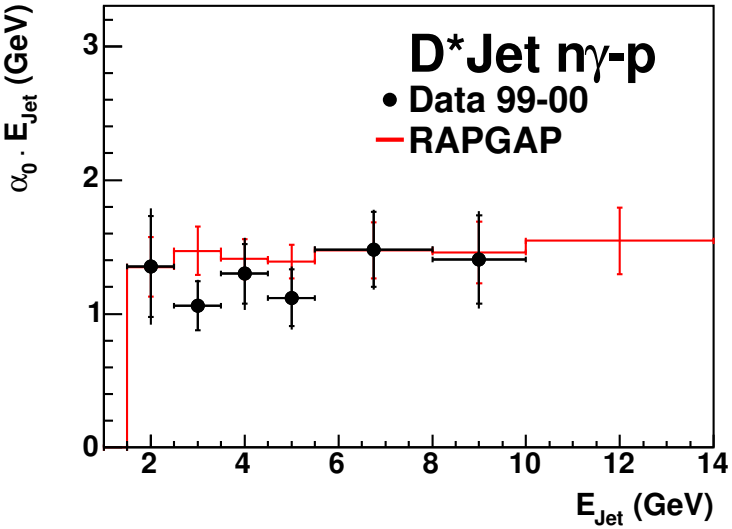
due to large errors one can not conclude about a clear difference

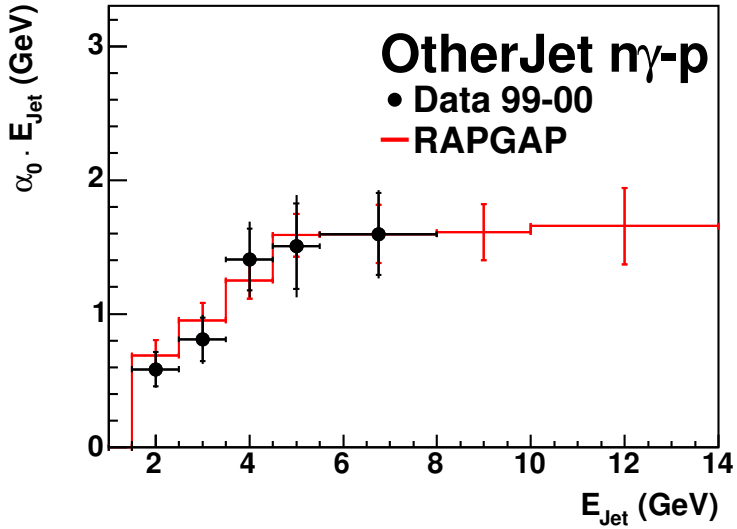

nγ-p frame
c (D*Jet)
p
c̄
P_z
P_⊥
γ
z
boost to γp frame
e'
p
e
y
x
z
c c̄ System
boost in − P_z direction
p − P_z
c (D*Jet)
nγp frame
γ
z

$\alpha_0 \cdot \langle E_{Jet} \rangle$ distribution in Lab. and $n\gamma$-p frame









Comparison of $\alpha_0 \cdot \langle E_{Jet} \rangle$ *between WrCh QCD model*